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Research Article

STUDY OF THE OBLIQUITY OF THE SHAFT OF THE FEMUR IN THE PUNJAB REGION

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ABSTRACT
Obliquity of the shaft of the femur was measured in 250 adult femora (170 males and 80 females) from osteology section of Anatomy and Forensic departments, SGRDIMSAR, Amritsar. The mean values obtained were 8.11 and 7.71 for right and left femora respectively in Males and 8.92 and 8.74 for right and left femora respectively in females. The obliquity of shaft of femora was more on both right and left sides in females as compared to males though the difference was statistically significant only on left side ($P<0.05$). Measuring of femoral obliquity angle helps in identifying sex of bone and has a role in reconstructive orthopedic surgery, Primatology and Paleoanthopology.

Key Words: *Obliquity of Femoral Shaft, Bicondylar Angle, Bipedal Gait*

INTRODUCTION
One of the distinctive features of hominin lower limb associated with adoption of bipedal locomotion is the presence of femoral obliquity angle that facilitates flexion and extension of knee in a parasagittal plane while positioning of knee close to the sagittal trajectory of body's centre of gravity (Tardieu, 2006). Femoral obliquity angle is the angle between an axis through the shaft of the femur and a line perpendicular to the intercondylar plane. Angle is generally higher in women due to their large interacetebular distance (Parsons, 1914; Pearson and Bell, 1919; Walmsley, 1933; Lovejoy and Heiple, 1970). There is no bicondylar angle in the femora of new borns and does not develop in children who do not walk (Tardieu and Trinkaus, 1994; Tardieu and Damsin, 1997). Some authors claim that the foetal and new born femoral Trochlea are flat as in chimpanzees and gorillas (Brattstran, 1964). Others proposed that very early in foetal life the general adult human form of femoral trochlea is achieved (Walmsley, 1940; Albanese 2003; Frutos 2003). On the basis of fossil record from 3-1.8 million years ago, (Tardieu, 1997) argued that an increase in femoral obliquity angle added as the initial change involving selection for deepening of trochlear groove and prominence of its lateral lip under the influence of an increasing tendency for full extension of knee joint. Because of obliquity of the shaft, this angle is essential for reconstruction of total length of femur and stature reconstruction from the total length (Trotter and Gleser, 1958, Lovejoy and heiple, 1970).

MATERIALS AND METHODS
The material used in this study consisted of 280 adult femora (170 males and 80 females) obtained from osteology section of Anatomy department and Forensic department of SGRDIMSAR, Amritsar. The bones showing any pathological lesion, fractures or from persons outside Punjab region, were not included in the study. The method used for the measurement was that of Lovejoy and Heiple, 1970. The femur was placed with the posterior surface of femoral condyles and greater trochanter, touching the smooth horizontal surface of an oseometric board, over which a sheet of paper was fixed. The condyles of

the femur placed against a vertical plate on the osteometric board. Transverse axis of the knee was taken as the plane of the vertical plate touching the lower ends of condyles and was drawn as a horizontal line on the paper. With the help of a vernier caliper, two points were marked on the paper showing maximum diameter of the femoral shaft at a level 25% of the standard maximum length of femur away from its distal end. Two other points were similarly marked in the paper showing maximum diameter of the shaft just below the lesser trochanter. The axis of the shaft of the femur was then drawn by joining the middle point of diameters at A and B, and prolonged downwards to meet the transverse axis of the knee. The angle between the axis of the shaft of the femur and the vertical axis (CD) meeting at the horizontal line of the knee joint denoted the bicondylar angle.

OBSERVATIONS

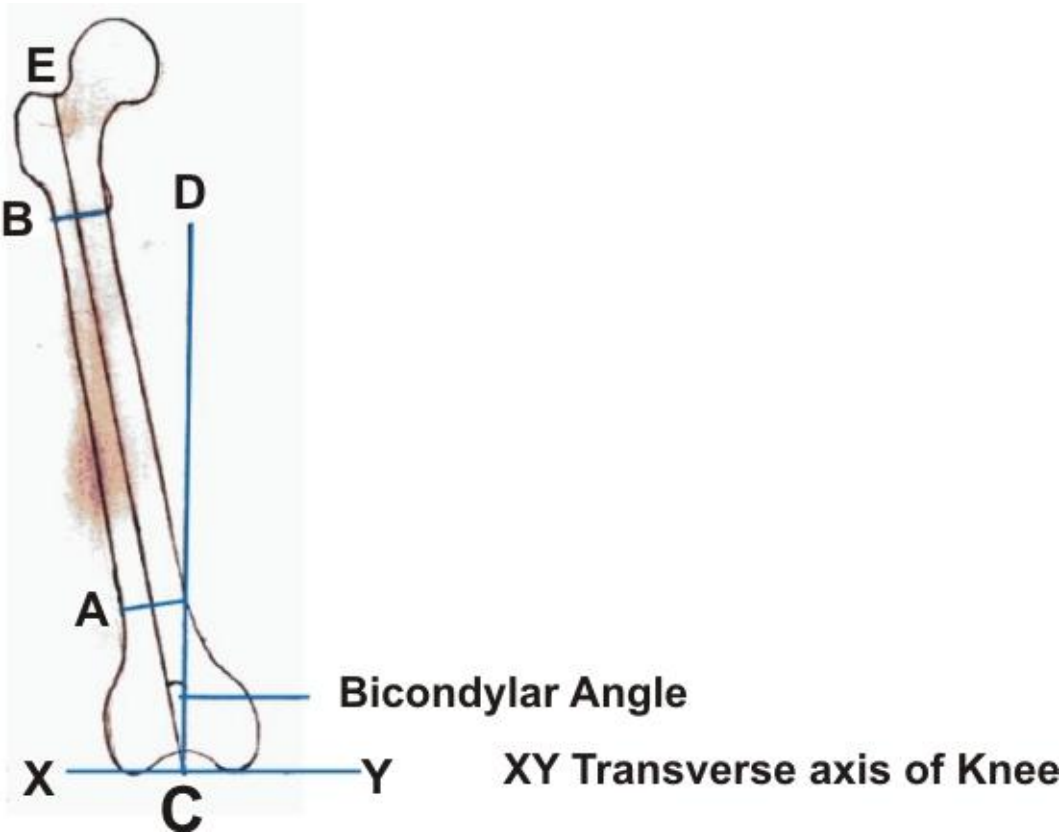

Figure 1: Bicondylar angle at C between the axis of shaft CE (Drawn by joining the mid points of maximum diameter of shaft of Femur at A & B) and vertical axis CD at C meeting at C

Table1: Measurement of bicondylar angle of femora in the present study

Sex	Side	No.	Range	Bicondylar angle			P Value
				Means	S.D.	S.E.	
Male	Right Left	85 85	2^o-14^o 3^o -14^o	8.17^o 7.89^o	2.311 2.230	0.220 0.200	>0.05
Female	Right Left	40 40	5^o-16^o 4^o-15^o	8.82^o 8.57^o	2.173 2.193	0.362 0.367	>0.05

The average angle in the Males was $8.17^{o} \pm 2.311^{o}$ on right side and $7.89^{o} \pm 2.230^{o}$ on left side. In the females, the average bicondylar angle was 8.82 ± 2.173^{o} on right side and $8.57^{o} \pm 2.193^{o}$n left side. The bicondylar angle of the right femora was more than the left in both the sexes but the side difference was statistically insignificant (P>0.05). The obliquity of the shaft of femur in females was more on both right and left sides than that of the males but this difference was also not statistically significant (P>0.05) except in the bones of left side.

DISCUSSION

Standard measurement currently taken with forensic human remains do not include the bicondylar angle (Steadman, 2009).The equation quoted by (Von Gerven, 1972) for measuring the bicondylar angle by using the maximum length and bicondylar length to estimate the angle is cosΘ= maximum length divided by bicondylar length. (Lovejoy and Heiple, 1970) quoted the equation, cosΘ = femur length divided by bicondylar angle. They found the mean bicondylar angle $9.43^{o} \pm 1.93^{o}$ in males and $10.5^{o} \pm 2.40^{o}$ in females in accordance with our study where mean bicondylar angle in males is $8.17^{o} \pm 2.311^{o}$ and in females is $2.173^{o} \pm 2.173^{o}$. (Ruff, 1955) described the measurement for the bone length and the line perpendicular from the table in which the bone is resting on, that is level with the superior surface of the femur neck to create the bicondylar angle. So equation quoted by him is cosΘ= Line perpeudicular to the table divided by bone length. Many studies have linked the obliquity with bipedality but the mechanism for the obliquity is poorly understood. Mechanical factors such as stress and strains influence the growth process as shown by (Shefelbine, 2002). The obliquity of shaft of femur exhibit sexual dimorphism and comparison with previous studies demonstrated regional and racial variations as shown in Table II

Table 2: showing comparison of Bicondylar angle measured by various authors.

Sr. No.	Year	Study	Parameters	Right		Left	
				Male	Female	Male	Female
1.	1919	Pearson And Bell	Range Mean S.D.	$8.69^{o} \pm 0.09^{o}$ — —	$9.39^{o} \pm 0.11^{o}$ — —	$11.59^{o} \pm 0.08^{o}$ — —	$11.77^{o} \pm 0.10^{o}$ — —
2	1974	Singh and Singh	Range Mean S.D.	2^{o}-13^{o} 8.16 2.21	5^{o}-16^{o} 8.82 2.17	3^{o}-16^{o} 7.79 2.20	3^{o}-13^{o} 8.67 2.21
3.	2005	Igbigbi and Sharrif	Range Mean S.D.	1.50^{o}-12^{o} 6.13 1.88	1.50^{o}-12^{o} 17.75 1.62	1.5^{o}-12^{o} 6.13 1.88	1.50^{o}-12^{o} 7.75 1.62
4.	2008	Pandya and Singel	Range. Mean S.D.	3^{o}-13^{o} 8.88 2.05	5^{o}-13^{o} 10.50^{o} 2.42	4^{o}-13^{o} 8.76 2.24	6^{o}-13^{o} 10.83 1.94
5.	2012	Present Study	Range Mean S.D.	2^{o}-14^{o} 8.17 2.31	5^{o}-16^{o} 8.82 2.17	3^{o}-14^{o} 7.89 2.23	4^{o}-15^{o} 8.57 2.19

(Tardiue and Damsin, 2001) have reported statistically insignificant sexual dimorphism of angle on both the side while in the adult Malawian population, (Igbigbi and Sharrif, 2005) have found significant sexual dimorphism bilaterally (Pandya et al, 2008) found higher obliquity in females was statistically highly significant on left side (P<0.001) and significant on right side (P<0.05) . In present study the bicondylar

angle of right femora was more than the left in both the sexes but the side differences were statistically insignificant (P>0.05) in accordance with findings of (singh and singh, 1974).

Conclusion

Mean value of femoral bicondylar angle in Punjabi Population was 8.17 on right side and 7.89 on left side in males and in females it was 8.82 on right side and 8.57 on left side. The Bicondylar angle of the right femora was more than the left in both the sexes but the side difference was statistically insignificant (P>0.05).

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